Fish of the Murray River

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Abstract
Fish are an integral component of the Murray River, contributing to its biodiversity, ecology and cultural heritage, as well as providing commercial and recreational fishing opportunities. Fish are an important way of connecting the community to the river system. The number of species in the Murray River is low by world standards; species range from the large, well known Murray Cod to smaller, lesser known species, such as Australian Smelt. Seven fish species are considered to be nationally threatened, with several other species threatened on a regional basis. Many of the threats to the fish species relate to the use of water and its associated infrastructure. Changes to flows, barriers to fish passage, cold water pollution, snag removal and habitat alterations, commercial and recreational utilisation, and interactions with introduced fish species have all contributed to the decline in fish populations. Many of these threats are currently being addressed or under consideration for changed management regimes to reduce their impact. Issues such as the provision of more water for improved environmental flows will pose ongoing challenges. The restoration of riverine ecological processes is a key way by which fish populations may be restored, and this needs to be undertaken with the support of the community. (*The Victorian Naturalist* **119** (4), 2002, 152-159)

Introduction

Although they largely remain hidden under the water surface, fish are an integral part of the fauna of any river system. This is no more so than in the Murray River, where the legendary 'mystique' of large species such as Murray Cod *Maccullochella peelii peelii* transforms their importance from being merely fish species to becoming important components of our folk lore and cultural heritage. Fish provide a major way in which the community can be connected to the river and its fauna (Sinclair 2001). Whilst Murray Cod are well known because of their size and status as a species of commercial and recreational significance, there are many other species which are also important but lesser known. Fish are an important component of the biodiversity, ecology and culture of the Murray River.

The native fish and their status

The number of fish species in the Murray River is relatively low by world standards, totalling only about 30 native species (Table 1), several of which are restricted to the lower river zones and associated with marine or estuarine reaches. Whilst this number of species may be expected of a river with a relatively low overall discharge, it can be compared to the more than 1300 fish species described for the Amazon Basin (Cadwallader and Lawrence 1990) and highlights the importance of the need for conservation of individual species. The majority of the species is widespread along the river, although some have distributions more suited to either the upper or lower zones. For example, Two-spined Blackfish *Gadopsis bispinosus* occurs in the higher reaches, whilst species such as the Bony Herring *Nematolosa erebi* are only found in the mid and lower river zones. A further group of seven diadromous species, which require access to marine/estuarine waters to complete part of their life cycles, are found in the lower zones of the river. These species include the Pouched and Short-headed Lampreys; *Geotria australis* and *Mordacia mordax*, Short-finned Eel *Anguilla australis*, Common Galaxias *Galaxias maculatus*, Tupong *Pseudaphritis urvilii*, Estuary Perch *Macquaria colonorum* and Blue-spot Goby *Pseudogobius olorum*. Other essentially marine species such as Mulloway *Argyrosomus hololepidotus* would also have entered the lower, estuarine river reaches more frequently in the past.

The exact number of fish species present is not really known, with the taxonomy of several groups undergoing revisions, including the hardyheads (Atherinidae),

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Table 1. Species list (From Pierce 1988 and Cadwallader and Lawrence 1990) and conservation status for freshwater fish of the Murray River. EPBC, Environment Protection and Biodiversity Conservation Act 1999, Protection Act; ASFB, Australian Society for Fish Biology 2001 listing; CE, critically endangered; E, endangered; V, Vulnerable; Epop, endangered population in New South Wales; FFG, listed under the Flora and Fauna Guarantee Act, Victoria. P, New South Wales Protected species (i.e. no take); (P), Protected from commercial take; UC, under consideration.

		Listing			
		National		Vic	NSW
Common name	**Scientific name**	**EPBC**	**ASFB**		
Native freshwater species					
River Blackfish	*Gadopsis marmoratus*			DD	
Two-spined Blackfish	*Gadopsis bispinosus*				
Broad-finned Galaxias	*Galaxias brevipinnis*				
Flat-headed Galaxias	*Galaxias rostratus*		V	DD	
Mountain Galaxias	*Galaxias olidus*			DD	
Murray Cod	*Maccullochella peelii peelii*	UC		V, FFG	
Trout Cod	*Maccullochella macquariensis*	E	CE	CE, FFG	E,P
Golden Perch	*Macquaria ambigua*			V	
Macquarie Perch	*Macquaria australasica*	E	E	E, FFG	V,P
Silver Perch	*Bidyanus bidyanus*		V	CE, FFG	V,P
Southern Pygmy Perch	*Nannoperca australis*				V
Australian Smelt	*Retropinna semoni*				
Freshwater Catfish	*Tandanus tandanus*		V	V, FFG	(P)
Bony Herring	*Nematalosa erebi*				
Southern Purple Spotted Gudgeon	*Mogurnda adspersa*		E	CE, FFG	Epop
Western Carp Gudgeon	*Hypseleotris klunzingeri*				
Midgeley's Carp Gudgeon	*Hypseleotris* spp.				
Flat-head Gudgeon	*Philypnodon grandiceps*				
Dwarf Flat-head Gudgeon	*Philypnodon* sp.			FFG	
Crimson Spotted Rainbowfish	*Melanotaenia fluviatilis fluviatilis*			DD, FFG	
Murray Hardyhead	*Craterocephalus stercusmuscarum fluviatilis*	V		E, FFG	E
Agassiz's Chanda Perch	*Ambassis agassizi*			Ex, FFG	Epop
Native diadromous species					
Short-headed Lamprey	*Mordacia mordax*				
Pouched Lamprey	*Geotria australis*				
Short-finned Eel	*Anguilla australis*				
Common Galaxia	*Galaxias maculatus*				
Tupong	*Pseudaphritis urvillii*				
Estuary Perch	*Macquaria colonorum*				
Blue-spot Goby	*Pseudogobius olorum*				
Introduced species					
Brown Trout	*Salmo trutta*				
Rainbow Trout	*Oncorhynchus mykiss*				
Carp	*Cyprinus carpio*				
Tench	*Tinca tinca*				
Goldfish	*Carassius auratus*				
Redfin (English Perch)	*Perca fluviatilis*				
Gambusia	*Gambusia holbrooki*				
Weatherloach	*Misgurnus anguillicaudatus*				

galaxiids (Galaxiidae) (T Raadik pers. comm.) and gudgeons (Eleotridae), which include hybrid species (Bertozzi *et al.* 2000). New genetic techniques are also being used to investigate several other species and these taxonomic revisions could result in the description of new species. Eight introduced species are also present in the Murray River. One additional native species, the Broad-finned Galaxias *Galaxias brevipinnis*, is now present in the upper and mid reaches where it has been introduced from east coast rivers through flows from the Snowy Mountains Scheme (Waters *et al.* 2002). This normally diadromous coastal species appears to

be completing its life cycle landlocked in freshwater, as occurs in the highland lakes in Tasmania (Fulton 1990).

Fish species range in size from the Murray Cod, which is Australia's largest freshwater fish (recorded up to 113 kg), to smaller species such as the Australian Smelt *Retropinna semoni* which weighs only a few grams. Photographs, illustrations and detailed information on these fish species can be found in the following texts: Cadwallader and Backhouse (1983), Merrick and Schmida (1984), Koehn and O'Connor (1990a), McDowall (1996) and Allen *et al.* (2002).

It has been recognised that most native fish species in the Murray River have suffered major declines (e.g. Cadwallader 1981; Cadwallader and Gooley 1984). The causes of such declines have been discussed by many authors (e.g. Cadwallader 1978; Koehn and O'Connor 1990b; Kearney *et al.* 1999). There is concern about the long-term future of many species, with seven already being considered nationally threatened (Table 1), including the critically endangered Trout Cod *Maccullochella macquariensis* (Fig. 1) (Australian Society for Fish Biology 2001). The natural range of this species is now restricted to about 120 km of the Murray River, immediately downstream of Lake Mulwala. Whilst this species has been stocked from hatcheries into the upper Murray River and other sites, these fish have not yet formed self-sustaining populations. Many other species have reduced or fragmented ranges and are listed as threatened in either NSW or Victoria (Table 1). Concern has been expressed at the status of many of these species in South Australia (Pierce 1988).

The capture of Trout Cod and Silver Perch is now prohibited in both New South Wales and Victoria. Of particular community concern is the decline of many 'flagship' species such as Murray Cod, Trout Cod, Silver Perch *Bidyanus bidyanus* and Catfish *Tandanus tandanus*. These species are readily identified by the public, and their loss indicates that all is not well with the health of the river. The fish community in the lower Murray River has been listed as endangered in New South Wales (New South Wales Fisheries 2002) and under the Flora and Fauna Guarantee Act in Victoria (www.nre.vic.gov.au).

Fig. 1. Trout cod *Maccullochella macquariensis* is now critically endangered. The only remaining natural recruiting population occurs in the Murray River, downstream of Lake Mulwala.

Commercial fisheries for species such as Murray Cod, Golden Perch *Macquaria ambigua*, Silver Perch and Catfish have all been greatly reduced or ceased (Reid *et al.* 1997). Recreational angling remains popular and many native species such as Murray Cod and Golden Perch are keenly sought. Lake Mulwala provides one of Australia's premier Murray Cod fisheries but cod from it appear to use both the Murray and Ovens rivers upstream for spawning (Koehn 1996). This highlights the importance of tributary streams to the fish of the Murray River system.

Fish habitats, needs and threats

The state of fish habitats and threats to them vary along the river. Recent scientific assessments of flow and environmental impacts along the Murray River (Thoms *et al.* 2000; Jensen *et al.* 2000) highlight how threats change through the reaches (Table 2). For example, cold water pollution is an issue downstream of Lake Hume and Dartmouth Dam (on the Mitta Mitta River) and barriers to fish passage more an issue in the lower reaches. Many of the threats are related to the human use of water and associated infrastructure and the issue of environmental flows was a reoccurring one. In essence, fish need instream structural habitat and access to it, suitable water conditions in terms of quantity and quality and a functioning ecosystem to provide food resources.

The native fish present in the Murray River could be described generally as a 'warmwater' species assemblage. Water

Table 2. Major threatening processes for fish in the Murray River summarised from Thoms *et al.* (2000) and Jensen *et al.* (2000).

Reach	Major threatening processes relating to fish
Dartmouth Dam to Lake Hume	Constant flows, unseasonal high flows, reduced flooding, unseasonal water temperatures, reductions in snags
Lake Hume to Tocumwal	Constant flows, unseasonal high flows, reduced flooding, unseasonal water temperatures, reductions in snags
Tocumwal to Torrumbarry	Unseasonal high flows, reduced flooding, constant flows, reductions in snags
Torrumbarry to Wentworth	Reduced flows variation and flooding, reductions in snags, constant flows, barriers to fish passage, increased turbidity
Wentworth to Wellington	Reduced flooding, barriers to fish passage, reductions in snags, possible fish health impacts from Lake Victoria.
Lower lakes and Coorong	Reduced freshwater flows, barriers to fish passage

temperature is important for the functioning of fish populations, particularly for reproduction, larval survival and optimal growth. The release of cold water from low level outlets in impoundments poses a major problem to warmwater fish, restricting the success of spawning and may have detrimental effects on metabolic function and growth rates (Koehn 2001). This is highlighted in the upper zones of the Murray River where high volume, cold water irrigation releases occur from the low-level outlets of Dartmouth Dam and Hume Dam. Three species of warmwater native fish (Trout Cod, Macquarie Perch *Macquaria australasica* and Murray Cod) have disappeared from the reaches of the Mitta Mitta River downstream of the Dartmouth Dam. It is likely that recruitment of these species has not been possible due to cold water releases during the spawning season of this species (Koehn *et al.* 1995). Low water temperatures from Lake Hume is likely to continue to restrict Murray Cod recruitment in the river downstream. The Murray River also receives water of unknown temperatures from the Snowy Mountains Scheme (Jacobs 1990). Cold water does however favour introduced species such as Brown and Rainbow Trout *Salmo trutta* and *Oncorhynchus mykiss* that can prey on smaller native species.

Reproductive strategies vary among species. Some species such as Golden Perch and Silver Perch produce up to 500,000 eggs which are laid in the water column and left without care by the parents. In contrast, species such as the River Blackfish *Gadopsis marmoratus* lay only a few hundred adhesive eggs on a wood substrate that are dependent on parental care. It has often been contended that many fish species have their recruitment aided by flooding, being able to exploit the high food availability on floodplains in times of floods. Whilst there is little evidence for use of the floodplain (Humphries *et al.* 1999), nutrients from the floodplain can be released during flooding and support an increase in production of algae, aquatic plants, zooplankton and other invertebrates that provide rich food sources for juvenile fish (Gehrke 1991). Reduced flooding, together with diminished flow levels could significantly decrease juvenile habitat availability and food production areas. A further complication is the clearance and replacement of native vegetation with flood intolerant exotic crops and pastures. Under such conditions, floodwaters rapidly become de-oxygenated as microbial communities decompose the flooded vegetation. This may adversely affect the survival of certain fish species, particularly when movement to other areas is restricted (Gehrke 1991; McKinnon and Shephead 1995).

Fish can be mobile, and many have a need to move widely throughout the river system. Species such as Golden Perch are mobile (Koehn and Nicol 1998), with some individuals migrating over 1000 km (Reynolds 1983). It has recently been discovered that high numbers of juvenile fish of species, such as Silver Perch, also move upstream (Mallen-Cooper *et al.* 1996), presumably to recolonise. Species, such as Murray Cod, which were previously thought to be sedentary have been shown to undertake pre-spawning migrations (Koehn 1997). Whilst these species may be

able to survive and reproduce even if such movements are not able to take place, their ability to recolonise and their ultimate survival and distribution over the longer term may be detrimentally affected. Lake Hume, Lake Mulwala and Torrumbarry Weir all pose barriers as do the many locks and weirs in the river downstream of Euston.

Many other species, especially those in the lower zones of the river, have parts of their life cycle that must be completed in saline water (normally the sea) and hence have to migrate to complete their life cycles. Barriers at the barrages (Murray mouth) prevent movements to and from the sea as well as preventing the occasional entry of many marine species. Some migrations are understood to occur in a particular season, for a particular reason, e.g. for spawning, and may often be affected by changes to flows. However, our understanding is not complete for all movements. Hence fish passage should be available to all species throughout the year. Aggregations of fish migrating upstream often occur immediately downstream of barriers (weirs and dams) making these fish very susceptible to capture by anglers.

Increases in water levels, both large and small, can stimulate the movement of fish (Mallen-Cooper *et al.* 1996). Reductions in flooding may restrict such movements, as might constant flow levels. The limiting of cues and the barriers to movement may affect spawning success and the distribution of species. Sudden reductions in flow levels can also lead to the stranding of fish.

Another form of fish movement is the drift of larvae (Koehn and Nicol 1998; Humphries and Lake 2000; Humphries *et al.* in press). This has the purpose of recolonisation and distribution of offspring, and can be affected by altered flow rates and impounded waters. High irrigation flows during early summer may mean that larvae are carried greater distances than would have occurred naturally. Impounded waters can trap larvae and prevent their distribution downstream. Such effects can alter the structure of fish populations. Larvae can also be transferred into irrigation channels where they are unlikely to survive (Koehn and Nicol 1998).

Fish numbers are often related to the amount of habitat available. Of course there must also be access to this habitat, which can be blocked by barriers. Snags or large woody debris are the major form of structural habitat in lowland rivers and are widely used by many species (Koehn 1993; Koehn and Nicol 1998). The use of this habitat by species such as Murray Cod has long been recognised (Koehn 1997). Snag removal has been widespread throughout the river, with snag numbers now considerably less than those that occurred naturally. Snags are used as home sites for territory formation, predator avoidance and prey detection. They offer protection from high water velocities, and are sources of food and spawning sites for many species. Snag removal has caused a major loss of fish habitat.

Many other floodplain habitats, such as billabongs and wetlands, have also been degraded, removed or made inaccessible. Habitats in the form of pools and scour holes can also be lost through infilling by sedimentation. Removal of snags and bank erosion can lead to a more uniform channel without a diversity of habitats. Variations in depth and velocities are also important to provide the suitable habitat for all species throughout their life cycle, and the presence of snags promotes such habitat diversity.

Eight introduced fish species are also present in the Murray River. Of these, Carp *Cyprinus carpio*, Redfin *Perca fluviatilis* and Gambusia *Gambusia holbrooki* are the most widespread. Carp receive the most public attention and are often blamed for many of the ills of the river. Recent reviews (e.g. Koehn *et al.* 2000) indicate that they are typical invasive species, which are tough and well adapted to making the most of already degraded riverine environments. With minimal predation pressure from reduced populations of native species such as Murray Cod and Golden Perch, Carp populations have expanded rapidly. Now in large numbers they contribute to water turbidity, uproot aquatic plants and utilise large amounts of habitat space. It is estimated they make up 90% of fish biomass in many reaches of the Murray River (Harris and Gehrke 1997).

The introduced salmonid species (mainly Brown and Rainbow Trout) are restricted mainly to the upper river zones (above

Lake Mulwala) and are keenly sought by some anglers. Together with Redfin, these species are formidable piscivores, which can impose predation pressure on smaller native fish species. Redfin populations appear to be reduced in many areas compared with the past (Cadwallader 1977), but this species persists throughout the river, particularly in still waters. Gambusia have been implicated in the harassment of fish through fin nipping and potential predation of eggs (Cadwallader and Backhouse 1983), but their impact on native species is not known.

Goldfish *Carassius auratus* are common, often in high numbers in the lower river reaches. Oriental Weatherloach *Misgurnus anguillicaudatus* are an aquarium species now present in the Murray River from Lake Mulwala to Barmah. Their distribution has increased downstream from the Ovens River. The impacts of this hardy species, which can survive in damp mud, is not known. Other introduced species such as Roach *Rutilus rutilus*, Atlantic Salmon *Salmo salar* and Brook Trout *Salvelinus fontinalis* have been recorded in the Murray-Darling Basin (Cadwallader and Lawrence 1990). Whilst not yet present in the Murray River, the coastal species Spotted Galaxias *Galaxias truttaceus* has also recently been recorded in the Campaspe River (P Humphries pers. comm.), presumably after a translocation.

Many of the fish species of the Murray River are or have been sought after for their commercial or recreational significance. Commercial fishing has undoubtedly taken a toll on numbers of some fish species in the past (Rowland 1989). Today however, most catch is from recreational take and this is not well quantified. Commercial native fin fishing now only continues in South Australia and this is likely to be reduced or phased out in the near future. The reduction of species other than those sought by fishers indicates that this was not the only cause for the decline of Murray River fish species.

Conservation efforts and the future

A Fish Management Plan for the Murray River was initiated in 1991 (Lawrence 1991) outlining management action to be taken to improve fish populations. This plan is to be superseded by a Native Fish Strategy (Murray Darling Basin Commission 2002) which will address key components for the restoration of native fishes across the Murray-Darling Basin, including the Murray River, over a 50 year time frame. Recently, the river has been assessed in relation to environmental flows and other threats, with many options for actions being canvassed (Thoms *et al.* 2000; Jensen *et al.* 2000). Several of the options discussed, together with other management actions, are already planned or under way. Some of these actions can be initiated readily whilst others must be structured over the longer term. The provision of better environmental flows was one recommendation which was seen to have the most benefit for the whole river (Roberts *et al.* 2001) and negotiations to improve environmental water allocation and its delivery are being undertaken through many different forums.

Options are now being considered for the remediation of cold water releases from Lake Hume. A fish lift has been installed at Lake Mulwala to assist with fish passage past that structure and a fully operational fishway has been installed at Torrumbarry weir (Mallen-Cooper *et al.* 1995). There is anecdotal evidence of increased numbers of Silver Perch upstream of Torrumbarry following the installation of that fishway. Modifications to existing, poorly functioning fishways and the construction of new fishways are intended for all structures downstream of Torrumbarry including the Barrages at the river mouth (J Barrett pers. comm.).

A considerable amount of research has been undertaken in the Murray River to improve our ecological knowledge of fish in this ecosystem. The general movements and habitat use of Murray Cod, Trout Cod and Golden Perch have been investigated (Koehn and Nicol 1998). Particular emphasis has been placed on investigating the downstream movements of fish, especially Golden Perch, with respect to interference to this type of movement caused by weirs (J O'Connor unpubl. data). Study of the downstream movement of fish larvae has also been undertaken. A resnagging project (adding large woody debris) has been undertaken downstream of Lake

Mulwala to provide additional habitat for Trout Cod and other species. This project has determined the structure and pattern of snags and is currently monitoring recolonisation by fish and macroinvertebrates. Study of movements and recruitment of carp around Barmah has highlighted this area as a likely key source of recruitment for the river (Stuart *et al.* 2001). This new information has been included in a new carp management plan for the area.

National recovery plans have been prepared for Trout Cod (Brown *et al.* 1998), Silver Perch (Clunie and Koehn 2000a) and Freshwater Catfish (Clunie and Koehn 2000b). Whilst the latter two plans are yet to be implemented, the ecology of Trout Cod has been investigated and monitoring of the Murray River population undertaken. Recent data indicate that this population is at least stable and may be expanding downstream. The provisions of fish passage at Lake Mulwala may allow this species to colonise the lake and expand its population upstream into the Ovens and Murray Rivers. Ideally, this would link the population to the fish currently being stocked in the Ovens River as part of the national recovery plan.

The restoration of ecological processes, such as migration, recruitment and organic production and cycling, must be recognised as key components for restoring the Murray River. With these processes in place, the fish populations then have a chance to re-establish and increase. This ecosystem approach to management must include the tributaries and catchments of the river. Ultimately, the management of the river must include and be supported by community ownership.

As a result of increased knowledge and recent and intended management actions, there are some positive signs for fish in the Murray River. The provision of fish passage throughout the river will allow the entry of some marine species, allow species with marine life stages to recolonise the river successfully and allow migratory fish within the river to move and recolonise freely. This should improve the distribution of species such as Tupong, and Silver Perch. More natural water temperatures downstream of Lake Hume can only be a positive for the recruitment of warm water species such as Murray Cod and Golden Perch. The provision of fish passage at Lake Mulwala may allow the Trout Cod and Silver Perch populations downstream to establish in the lake and rivers upstream. Additional water to meet environmental needs is still required to provide adequate environmental flow conditions to restore some of the key flow components, which maintain ecosystem processes. This will remain one of the biggest challenges for the restoration of fish populations in the Murray River.

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